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| **[Nile 3 on targeting and scaling out : On the analysis of land and water use systems in the blue nile basin]** |
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# Introduction

Nile 3, is a project component on the Nile Basin Challenge program (NBDC) funded by the Challenge Program on Water and Food (CPWF). The aim of the overall project is to increase the resilience of livelihoods in the Ethiopian Blue Nile using water management as an entry point. The component 3 focused on targeting and scaling out rainwater management strategies aiming at understanding which rainwater management practices works where based not only on bio-physical but also socio-economic criteria and how to combine these practices in order to manage watersheds in their integrity.

The objective was not only to provide concepts and approaches for better targeted rainwater management, but also to reach an attitude change across different types of stakeholders, namely local researcher, local and national planners and donors to promote context specific combinations of rainwater management practices.

Nile 3 project tried over two years to develop the concepts of rainwater management strategies at landscape scale, to produce suitability maps for better targeting for which many new geographical and non-geographical data has been collected and processed as well as promote the attitudinal change among our stakeholders.

The objectives where summarized into four following narratives :

*While research on NRM and agricultural development is conducted at various levels in Ethiopia, the in-appropriateness of "blanket approaches" has not been fully understood by the researchers in the national research institutes. In consultation with researchers, implementers and policy makers, N3 will come up with a generic methodology for matching technologies with environments. N3 will conduct tailor-made GIS and spatial analysis training at OARI and ARARI, enabling us to collaborate in data collection and validation, co-develop suitability maps for particular sets of practices. By doing this we'll support researchers in the national research institutes to increase their technical capacity to apply evidence based analysis and GIS approaches to tailor interventions to different social and ecological landscape niches.*

*N3 contributes to potential policy change by participating in national policy dialogue processes lead by N5, providing results and ensuring relevance of these results through early engagement. The N3 team will work together with policy makers, researchers and implementers to come up with RMS definition and scenarios; they will also work out the requirements of targeting tools and maps, so that the needs of different stakekolders are taken into account. As the actual targeting analysis is likely to remain the responsibility of technical analysts in the national research institutes, N3 will endeavour to bring technical and policy actors together through workshops and follow-up discussions, thereby fostering a collaborative attitude.*

*It is thought that frameworks and methods for 'targeting and outscaling' are needed by regional researchers and development agents alike to strengthen research impact and rainwater management strategies throughout the Nile Basin. N3 (in close collaboration with N2) will demonstrate the value of targeted RMS and endeavour to provide intermediate and final outputs to regional players throughout the project life. Concise and clear policy messages will be developed and feed into the relevant on-going policy dialogues (through N5).*

*The methods and data for targeting and outscaling are needed by other Nile BDC projects. N3 will co-develop the research frameworks, the list of potential RMS and scenarios together with NARES and the other Nile BDC projects (N2 and N4), to ensure that results of the different projects are compatible and serve the needs of associated projects and other researchers in the region. N3 will endeavour to provide intermediate as well as final outputs to other BDC project in a timely way so that they can use them, and will these through traditional scientific channels and CPWF TWG to serve the larger scientific community.*

This report aims at giving an overview about all activities that have been implemented in the frame of the Nile 3 project to contribute the these objectives, describe how the lessons learnt have influenced the project as well as the key messages that result from the work done.

# Overall messages from the Nile 3 project

Not only rainwater management practices are interconnected at farm scale but also at landscape scale. Therefore holistic approaches should be applied within manageable watersheds. Rainwater management practices can be combined into strategies by combining practices that together increase soil and water conservation, water infiltration and water productivity of the landscape. Multiple rainwater interventions should be considered by farmers, with combinations of practices defining a strategy which is most appropriate for the biophysical and socioeconomic conditions.

Adoption of rainwater management practices has a lot of interdependencies and requires therefore a holistic approach. The suitability of rainwater management technologies is likely to be influenced by the landscape. Site-specific bio-physical and agro-ecological but also socio-economic characteristics are important to consider in the adoption/scaling-up of rainwater management technologies, i.e. “one size does not fit all”.

Analysis confirms that improved access to market, extension services and credit increases the probability of adoption of rainwater management practices. Reasons for non-adoption are, however, very context specific, therefore it is essential to identify the right entry point in each community. Communities generally have rational reasons for non-adoption of rainwater management strategies. Farmers are also well aware of the practices that are suitable in their agro-ecology.

Regional feasibility maps are critical to identify areas which are biophysically and socio-economically for targeting of rainwater management practices and particular strategies. Data availability is therein a big challenge. We could not easily get country data and this led to the use of global and regional datasets. Integrating the user/experts knowledge increases the credibility of the produced maps

Scaling-out tools can reach the farmers only if the national research works more closely together with the extension service/Kebele representative as the latter often do not have electricity, or computer to use our tools.

# Project outputs and activities

## A methodology for identifying what RMS works best

Quite a big part of the work consisted in developing a methodology that allows to identify which RMS works best where. Many interactions with stakeholders and other scientists have allowed us to come up with a methodology that answers the question risen by the stakeholders.

### Concept and definition rainwater management strategies at landscape scale (Catherine)

At the beginning of the project there was no clear understanding of what rainwater management at landscape scale is. Through various stakeholder meetings organized by our partners, we tried to understand their vision. The result from these meetings were that rainwater management practice are very well understood, and that the governmental guideline (participatory watershed guidelines) are well accepted and the suitability range relatively correct. However, the topic was too complex to learn from the stakeholders about the landscape scale.

Rainwater management practices can be combined into strategies by combining practice that together increase soil and water conservation, water infiltration and water productivity on different land uses.

Communication tools are needed in order to learn from stakeholders about the complexity of rainwater management

With valuable input from our partners –and special mention should be made of Dr. Gizaw (ARARI- we developed the concept of rainwater management at landscape scale as a combination of rainwater management practices that fulfill different functions in different niches of the landscape.

In order to validate this concept the Happy Strategy game has been developed (see chapter 3.1.3). The games played with stakeholder and scientists have shown that the concept is robust and accepted by everyone. The game form has proven itself as a useful way to discuss the complexity of the topic and bring together people from very different backgrounds.

**Outputs :**

*Poster* :

Presented at the CPWF water forum

(http://www.slideshare.net/CPWF/mapping-rainwater-management-strategies-at-landscape-scale)

Presented at the conference “water in Africa” in Mauritius

*Technical report :*

C. Pfeifer, A. Notenbaert, Y. Abebe, A. Omolo, *mapping rainwater management at landscape scale*, upcoming NBDC technical report

*Paper* **:**

C. Pfeifer, A. Notenbaert, D. Bossio, G. Desta, *mapping rainwater management at landscape scale*, submitted to agricultural water management

### A framework for targeting and scaling out (An)

Based on a body of previous and on-going work within ILRI and in collaboration with the CG Research Program on Climate Change, Agriculture and Food Security, we designed a generic methodology for out-scaling and prioritizing interventions in agricultural systems. This has been the guiding frame of most of our work.

The methodology entails a multi-stage and iterative process of (1) diagnosis and selection of options, (2) characterization of the options, (3) identification of the recommendation domains and out-scaling potential of these options, (4) assessing the impacts along different dimension and on different groups of people. The framework is applicable in many different forms and settings. The steps can be gone through qualitatively in a multi-stakeholder setting while the process can also be done quantitatively and through the application of models and e.g. trade-off analysis.

During the project life we’ve gone through several of the steps and developed innovative methodologies to aid this process. In support of stage one, we developed the happy strategies game. It can help in the diagnosis and elicit views on potential options to address the site-specific constraints (see section 3.1.3). We also consulted with several national stakeholders and identified the “best-bet” options as they are currently being promoted by the SLM program (section xxx). A lot of effort went into the description / characterization of the options. Previous knowledge about bio-physical and socio-economic conditions influencing suitability of a wide variety of RMPs was collated (section 3.2.3), while field studies were undertaken to increase our understanding of adoption of these options (section 3.2.4.7). Matching this characterization data with a spatial database (section 3.2.4) allowed us to map the suitability and feasibility of rainwater management options and strategies (section 3.2.5). To allow others to repeat this stage of mapping the recommendation domains, we developed an open-source GIS tool now available to all stakeholders (section ). We only made limited progress in the last stage of the methodology, i.e. the impact assessment. For this stage we worked in conjunction with Nile project 4. Based on our feasibility maps for best-bet strategies from SLM we identified the most-likely to be adopted strategy for each of the watersheds and translated this into maps compatible with the SWAT model (section 3.3). Results from the impact assessment should eventually feed back into the assessment of alternative options.

**Output**

*Report*

Herrero, Notenbaert, Thornton, Pfeifer, Silvestri, Omolo, Quiros. A framework for targeting and scaling-out interventions in agricultural systems. CCAFS discussion paper. In preparation. Draft available at[*http://nilebdc.wikispaces.com/targ\_scaling*](http://nilebdc.wikispaces.com/targ_scaling)

### Happy strategies (Catherine)

Games can break hierarchies and allow people from different back grounds to interact with each other on an equal base.

The initial Happy Strategies game can be adjusted to different objectives and different type of participants.

Initially developed to present our database of rainwater management practices at the CPWF meeting in South Africa in a funny way, the Happy Strategies game has very soon proven its strength as a non-conventional communication tool adaptable to many different situations.

The basic principle of the Happy Strategies game is to trade rainwater management practice cards to fit a particular well described landscape, i.e to form a happy strategy, a combination of rainwater management that fits the particularities of a given landscape. The rules of the game have to be adjusted to the objective of the game as well as to the prior knowledge of the participants concerning rainwater management and the Ethiopian context.

The game has been played with stakeholders in a broad stakeholder meeting and with international scientists at the CPWF meeting in order to validate our concept of rainwater management strategies at landscape scale (see chapter 3.1.1), in a training for water practionners as part of a training organized Meta Meta, a consulting company, as well as with 4 communities in the Blue Nile to validate the N3 suitability and feasibility maps (see chapter 3.2.4.7. )

In all the game played, existing hierarchies have been broken creating a creative space to find new solution that match the context well.

**Output**

*Website*

[www.happystrategies.wikispaces.com](http://www.happystrategies.wikispaces.com)

*NBDC technical report n4*

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|  | Pfeifer, C., Notenbaert, A. and Ballantyne, P.G. 2012. *The ‘happy strategies’ game: Matching land and water interventions with community and landscape needs*. NBDC Technical Report 4. Nairobi, Kenya: ILRI. |

*Paper*

C. Pfeifer, P. Ballentyne, A. Notenbaert, S. Langan, *Happy strategies: a quick inclusive participatory tool for context specific rainwater management at landscape scale*, in preparation for water alternatives

*Blog*

<http://nilebdc.org/2011/11/24/jegerida/>

<http://nilebdc.org/2011/11/20/happy-strategies-where-strategic-land-and-water-management-is-as-simple-as-playing-a-game>

## Creation of maps to identify what RMS work best and where in the basin in terms of bio-physical and institutional parameters

### Introduction

Despite of the theoretical understanding of many stakeholders that rainwater management practices don’t fit anywhere, Ethiopian policies still make use of so called blanket-approaches that is the promotion of rainwater management best practices regardless of the biophysical and socio-economic context. A good example of this is the terracing policy : each woreda (district) needs to reach a certain amount of terraces regardless of the topography.

Though suitability of many rainwater management are very well documented (wocat database, governmental guidelines), there is a lack of capacity to operationalize this knowledge it is not well known where the different conditions are met. Furthermore, though the socio-economic context is understood as being important, result from research is often contradicting and the link to the bio-physical context is difficult to make. This section presents the approach we have chosen to operationalize the existing knowledge on suitability of rainwater management strategies as well as how we have combined the socio-economic and biophysical context to support policy makers as well as practitioners to make better targeted recommendations.

### Similarity analysis (Catherine)

Nile 3 started off with the idea to up-scale information collected by the Nile 2 team on the three NBDC study sites. In order to understand to what extent these sites are representative for the basin, a similarity analysis has been performed. It consisted of a principal component analysis at woreda level on available biophysical and socio-economic data. This work was also a first step in bringing together all the available geographical layers for the Blue Nile together (see 3.2.4.1).

At basin scale, diversity can be summarized into 9 dimensions, namely, topography, access to education, remoteness, rainfall erosion potential, agricultural dependency, demographical processes, institutions, household composition and off-farm income.

At basin scale the 3 study sites are relatively similar, which does not mean that they might be very different when analyzed at lower scales.

The similarity analysis finds that basin scale, diversity can be summarized into 9 dimensions, namely, topography, access to education, remoteness, rainfall erosion potential, agricultural dependency, demographical processes, institutions, household composition and off-farm income.

At basin scale the 3 study sites, namely Diga, Jeldu and Fogera are relatively similar, i.e. sites share the same dimensions. This result does not mean that the sites are the same on the ground. In fact, each site has its own characteristic and own path of development. But this diversity cannot be captured at the basin scale with the available data.

This result supported the idea that for modeling the basin scale, information should be collected more broadly than from the NBDC study sites.

For these reason, Nile 3 has based its work on the governmental guidelines includes knowledge from many different sites across East Africa, as well as an already existing dataset from IFPRI collected in 15 different woredas of the Blue Nile.

**Ouput**

*Technical report*

Pfeifer, C., Notenbaert, A. and Omolo, A. 2012. *Similarity analysis for the Blue Nile Basin in the Ethiopian highlands. NBDC Technical Report 3.* Nairobi, Kenya: ILRI.

<http://mahider.ilri.org/handle/10568/21069>

*blog*

<http://nilebdc.org/2012/06/20/similarity-analysis-for-the-blue-nile-basin-in-the-ethiopian-highlands-new-nbdc-technical-report-guides-site-selection-and-likely-technology-spillovers>

### Rainwater management practices database (Catherine)

From the initial meeting with the stakeholders (see 3.1.1) we have learnt that experts and our stakeholder have a very good understanding of the biophysical suitability conditions for all of the major rainwater management practices. We learnt that the governmental guidelines, “Participatory watershed management” documents very well what works where. This document that exists in English and Amharic seems up until today the best reference in Ethiopia and is widely accepted. It is based upon the WOCAT database, a database that collected evidence over many years in different East African countries.

The participatory watershed management guideline from the government is a very extensive database covering water crop and trees, reporting very well about biophysical suitability conditions.

This database is still very actual when completed with some more livestock related practices.

Literature often finds contradicting results concerning socio-economic and institutional drivers. It is therefore difficult to add them to the database.

These guidelines are pretty comprehensive and cover water, crop and trees and explain in detail the bio-physical conditions needed and how to implement the practice correctly. To a certain extend it also discusses socio-economic conditions but not in a systematic way. Furthermore, livestock related practices, including better forage is not yet fully part of the guidelines.

The database Nile 3 developed started off the list of practices in the guidelines making use of the suitability conditions described there. This list has been completed with livestock related practices through a literature review and practices suggested from Nile 2.

A comprehensive literature review has been done to identify the socio-economic conditions that favor adoption of the practices in the database. This literature review showed that results from different studies often contract themselves on which socio-economic variable is relevant as well as on its impact on adoption. This makes it impossible to define socio-economic variables and relevant thresholds for suitability mapping. For this reason we decided to work with willingness of adoption maps (see 3.2.4.6)

Note that the most common practices from the database have been retained in the Happy Strategies game, in which each practice is described in an attractive way on card stating the objective of the practice, the bio-physical and socio-economic suitability condition as well as a picture (see 3.1.3).

**Output**

*the database*

<http://nilebdc.wikispaces.com/rainwater+management+practices>

*blog*

<http://nilebdc.org/2011/03/31/mapping-targeting-and-scaling-out-of-rainwater-interventions-technical-workshop/>

### Geo-database for Ethiopia

A great part of the N3 work consisted in developing a geo-database for the Ethiopian Blue Nile by collecting and bringing together the exiting geographical layer as well as creating the missing layer.

#### Secondary data (Yenenesh/Abisalom)

Previously, most of the data was in the hand of different individuals which made data

The Blue Nile geo-database comprised of different themes namely: Administrative

boundaries, Geology, Hydrology, Hydrogeology, Images, Infrastructure, Lu/LC Maps, Metrology,

Socioeconomic, Soil, Topography and Topomaps, which are of spatial and non-spatial in nature can be a potential source for research data inputs.

Getting the metadata information for the archived data as well as a common projection system was the great challenge

accessibility difficult. The Nile 3 project tried to bring all the available data together in one central place, allowing other researchers and other projects to access the data more easily.

The current database for the Blue Nile encompasses the following data boundaries, geology, hydrology, hydrogeology, satellite images, infrastructure, Lu/LC maps, metrology, socioeconomic, soil, topography and topomaps. This database has already been used for other project and is source of great information for many researchers, even those who are not per se looking for spatial data.

Bringing data that are stored by different people in one central database is challenging, tedious and time taking. Indeed, data often comes without any metadata, implying the one does not know from where it comes from or the rights the CGIAR has on this data. Furthermore, data also often lacks in information about the projection. Today, the data is all stored in one projection system, making it very easy to work with the different dataset. Also all the data has been documented as thoroughly as possible. Nonetheless, still today ILRI/IWMI has many dataset which ownership and right of use has to yet been clarified.

**Output**

*Database*

A well documented geo-database is available on the Addis geo-computer managed by IWMI

*Blog*

*http://catherinepfeifer.blogspot.ch/p/where-to-find-free-geodata.html*

#### Fire map (Lisa)

Under the N3 project, research was initiated to characterize the development trajectories within the BNB. This continues under the N2 project and the wider NBDC umbrella after the closure of N3 in December 2012. The effective targeting of interventions at the basin scale requires an understanding of past changes in land cover and land use. This work was begun under N3 with the analysis of fire occurrence and erosion potential across the basin.

Fire is a burning issue. It has been raised repeatedly by farmers in the basin, and analysis shows that large areas of the BNB burn every year, as part of the land management system. This frequent burning has complex effects on soil fertility, and processes of run-off, infiltration and erosion

Burning due to agriculture is widespread in the basin. The issue of fire has been raised again and again by farmers in the basin and national partners in Ethiopia with who we have interacted over the course of the project. While farmers and government agencies advocate burning as a way of increasing soil fertility, in the long term the effect is likely to be a decrease in soil fertility, due to modification of run-off and infiltration processes. Under N3 an analysis of fire was conducted for the basin – daily fire extent was mapped between 2000 and 2011, and a very clear pattern emerged, with large areas burning at the same time every year (Figure 1). The results are being used by N4 in the SWAT modelling, as fire will modify run-off and infiltration processes.

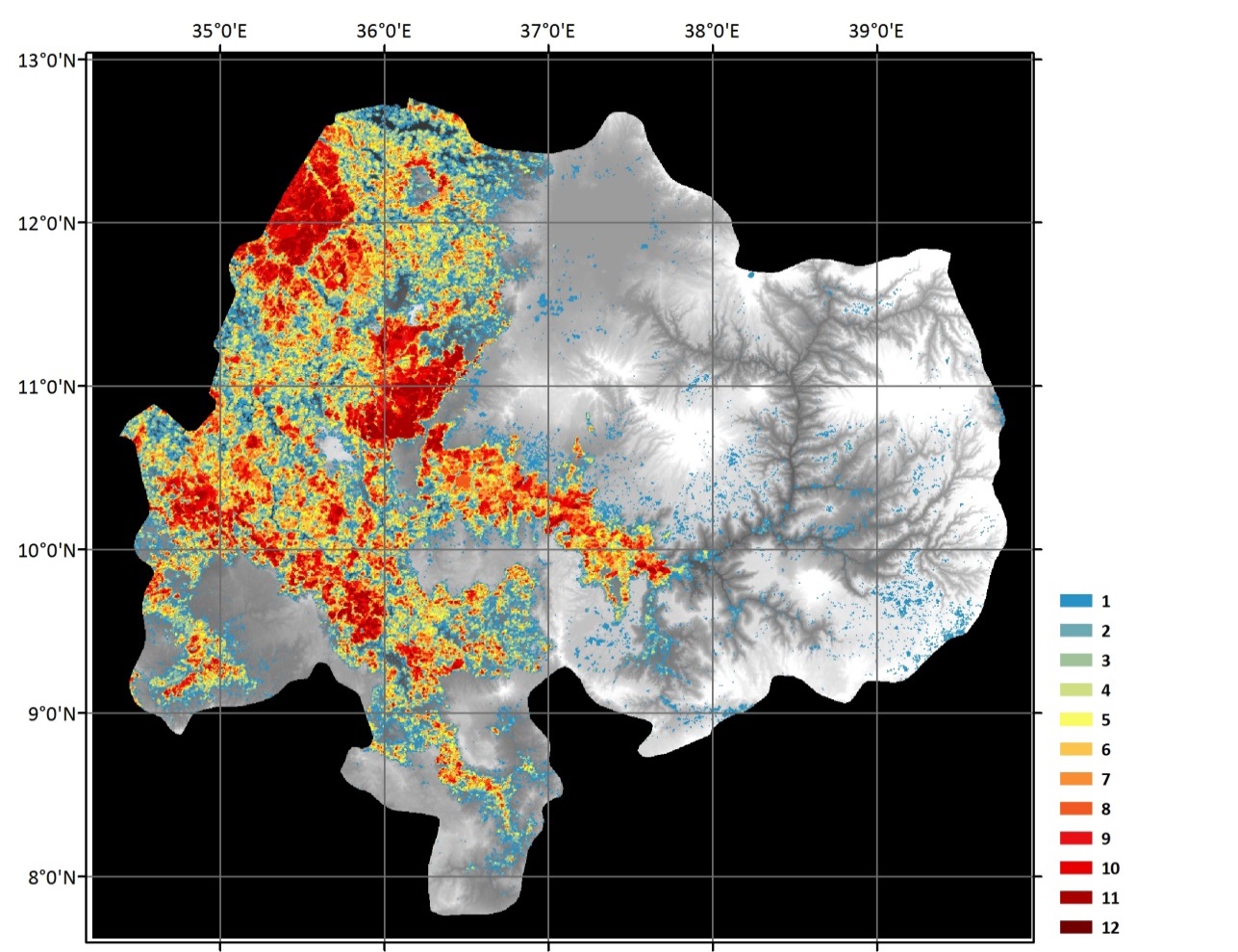


Figure 1: Frequency of burning derived from MODIS daily data acquired between January 2001 and December 2011 overlayed on the SRTM DEM

#### Market access map (An)

Based on road networks for the year 2005 and 2010, estimates were made of the time it takes to travel from anywhere in the Blue Nile basin to major markets.  These calculations are done through the creation of so-called cost surfaces, which combine estimates of travel speeds on roads, in different types of land cover data, and on different slope classes.

The travel time to major markets varies widely in the Blue Nile Basin.  The development of new roads has increased the accessibility of some areas considerably.

**Output**

New market access map

#### Erosion risk (Lisa)

Soil erosion potential within the basin has been modelled by adapting the popular RUSLE soil loss equation to the local, Ethiopian, conditions. The results indicate (Figure 2) that the north eastern and south eastern parts of the Basin are areas of extreme soil erosion. The lowland plains of the western and north western areas of the Basin are identified as having very low levels of soil erosion. The annual soil loss in the Abbay Basin is estimated to be in the range from 1.3 to 3.2 billion tons a year. Region based spatial statistics shows that nearly 65% of the soil loss is from Amhara, 27% from Oromia and 8% from Benishangul Gumuz Regional states. The findings not only reveal the spatial distribution and variations but also the intensity of soil loss which is an important factor in the prioritization and targeting of appropriate soil management interventions.

Soil erosion is occurring at a high rate in many parts of the basin, with annual soil loss estimated to be as  high as 3.2 billion tons per year. The north eastern and south eastern areas of the BNB demonstrate areas of extreme erosion, while overall 65% of the total soil loss occurs in the Amhara region

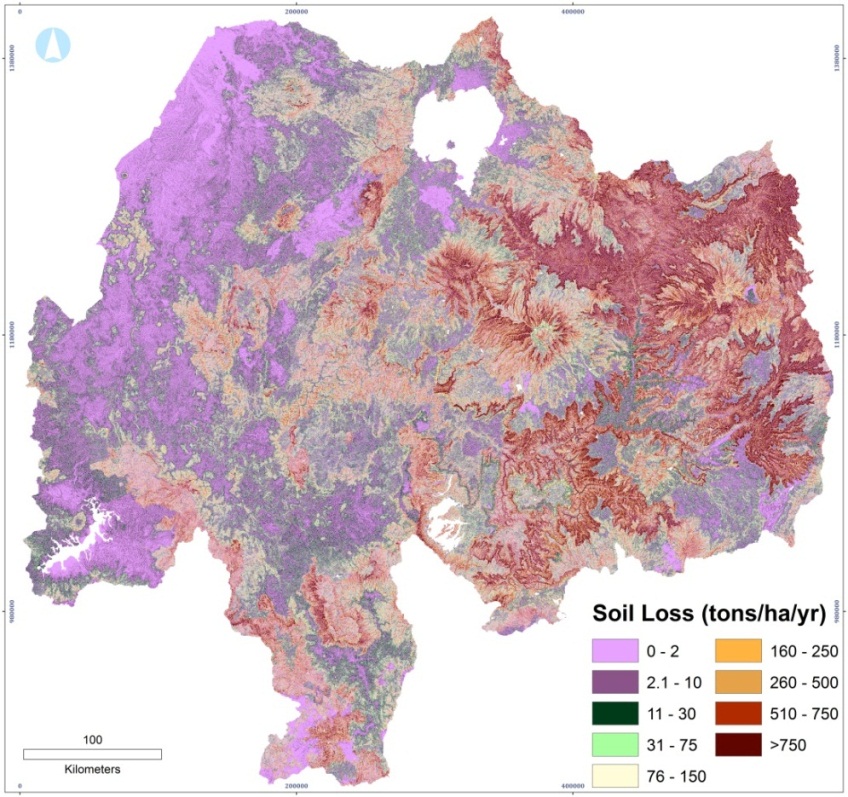


Figure 2: Modelled soil erosion potential

#### Rainfall maps (Jens)

In principal, precipitation (P) and potential evapotranspiration (PET) data of suitable temporal resolution (daily or weekly) are sufficient to characterize the moisture regime of a given location. However, water limitation of plant growth depends on a range of additional site-specific properties such as soil properties and slope as well as on the phonological stage of the plants. A robust methodology for targeting of RWM measures therefore needs to involve some measure of actual plant growth (e.g., normalized difference vegetation index). Although this kind of data can be used to directly estimate water limitation of photosynthesis in a modeling framework (Jarlan et al., 2008) it is here used to compare sites with comparable moisture regimes in terms of their “greenness”. Sites that appear less green than expected for their moisture regime use the available water sub-optimally and can therefore be upgraded by RWM.

The total amount of rainfall is sufficient to allow sustainable intensification of rainfed agriculture in most parts of the basin. In some regions in the northwest and the east, however, agricultural potential is limited by total available rainfall.

In some areas with in principal sufficient total rainfall a comparatively low NDVI indicates that the full potential can only be achieved with suitable RMW interventions.

The large spread of NDVI values in areas with insufficient total rainfall indicates that RWM interventions may help to upgrade rainfed agriculture although production will always be water limited.

Erosion is prevalent in the whole basin with no clear spatial pattern and with no significant differences in severity among the different RWM classes.

The analysis is based on daily time series of normalized difference vegetation index (NDVI), potential evapotranspiration (PET), and precipitation (P) for the period 2000– 2011 at 1 km spatial resolution. For NDVI a smoothed and gap filled version of the SPOT Vegetation NDVI product provided by A. Vrieling (pers. comm.) is used. The data set is downscaled to daily time step from its original 10-day temporal resolution by linear interpolation. PET is taken from the MODIS MOD16A2 8-day product (Mu et al., 2011). Values therein represent PET sums of the respective 8-day period and are downscaled to daily by copying the average to each day of the respective period. Precipitation is based on the latest version (v7) of the TRMM 3B42 product (Huffmann et al., 2007) with daily temporal resolution and a spatial resolution of 0.25 arc-degrees. The data was first interpolated to the 1 km target resolution by applying a bicubic remapping (remapbil from Climate Data Operators). To add subgrid information the monthly climatology from the 1 km product of the WorldClim data set (Hijmans et al., 2006) was used to calculate a set of 12 monthly correction factors for each 1 km grid cell. These factors were then applied to the entire time series to match the climatology of the TRMM data set in the 2000-2011 period to the observed climatology from WorldClim.

For the use in the subsequent analysis a mean annual cycle is obtained for each variable from the 11-year daily time series by calculating the average of the 11 values for each day of year; in leap years December 31 was omitted. The analysis described in the following could in principle be applied to the original time series but more robust results are obtained form the mean annual cycle and inter-annual variability is not in the focus of this the analysis.

As mentioned above the calculation of any water related index from annual means strongly limits its significance in regions dominated by precipitation seasonality. The first step of the analysis therefore consists of the determination of a representative growing period. There are a number of approaches documented in the literature that are based on climate data or NDVI data. Approaches using NDVI data are usually more robust as they based on direct observations of the phenology. For the analysis here, however, a variable length of the growing season is not desirable as it hampers comparability if the length varies too much. Therefore a fixed length of 100 days was used and the period with the highest average NDVI was used as representative growing period here. For the determination of this period a 100 day moving window was applied to the NDVI curve; to allow for full application to the annual cycle the annual cycle was repeated after December 31.

For each identified growing period the overall P/PET ratio is determined, which can be understood as average water availability to demand ratio for that period. In Fig. 1 all pairs of mean NDVI and corresponding P/PET ratio are plotted. Based on the distribution of points the following domains are defined: Maximum NDVI at P/PET = 1 is 0.7–0.8, so 0.7 is taken as the optimal achievable NDVI. In all locations with NDVI values above 0.7 or with P/PET > 1.4 plant growth is assumed not to be limited by water (class 1). Towards lower P/PET values the upper envelop of NDVI values decreases and becomes smaller than 0.7 at about P/PET = 0.7. This means that precipitation sums of about 70% of PET are sufficient to allow plant growth with little or no limitations. If NDVI is less than 0.7 under theses conditions a better utilization of water can substantially increase plant growth. These locations are the target area for RWM measures (class 2) where smart management of available moisture can in principal completely alleviate water limitation on plant growth. It should be noted that the method cannot distinguish between reduced greenness due to water limitation or other growth limiting factors (e.g., nutrients).

However, the zonal distribution of these locations both in the Fig. 1 and the map in Fig. 2 strongly support the assumption that an unfavorable rainfall regime with high variability prevents the optimal use of the available water. There is also risk that the NDVI threshold separates forests and croplands rather than rainfall regimes. An analysis of land cover types reveals a similar distribution of cropland and cropland mosaic (42% and 56% in class 1 and class 2, respectively) so that the influence of this effect on the classification should be small.

With further decreasing P/PET ratio the maximum achievable NDVI decreases further showing that the total amount of available water is limiting plant growth. However, down to a P/PET ratio of 0.35 NDVI values of 0.5 are achievable, which indicates that rained agriculture is still possible (class 3). But a smart management of rainwater is even more important under these moisture conditions as the majority of NDVI values in this class are much lower. Below a P/PET of 0.35 maximum achievable NDVI quickly decreases to values as low as 0.2 and rainfed agriculture is assumed to be not possible or too riskyhere (class 4).

**Output**

Rainfall regime maps

#### Adoption maps (Catherine)

A comprehensive literature survey (see 3.2.3) showed that studies find very contacting results concerning socio-economic suitability criteria. It makes it impossible to define socio-economic variables and even more their thresholds to define suitability. Therefore, we decided to work with “willingness of adoption maps” that can be constructed with the small area estimation technique, a technique that is commonly used for poverty mapping. We adjusted this technique to fit the non-linear nature of adoption, that is assessed as binary variable (adoption, non-adoption) It makes use of a farm household survey (IFRPI farm household survey from CPWF phase 1) from which adoption is assessed with an econometric model. This model is the use to predict adoption at woreda level using full coverage data, namely the census data presented in the Rural Economic Atlas.

Small area estimation technique can be adjusted to cope with non-linear adoption models and map out willingness of adoption.

For half of the practices analyzed, the spatial trend was explaining adoption, suggesting that the available socio-economic data could not capture the geographical diversity.

Adoption maps for soil and water conservation, multipurpose tree, fruit trees (orchards), water harvesting, irrigation from the river and wells have been produced based on an econometric model of adoption, once without a spatial trend once with a spatial trend. Introducing a spatial trend implies to include the coordinates of the farm into the econometric model and is the easiest way to account for spatial variables that are omitted in the model. If the spatial trend is significant in the model, then it suggests that the socio-economic variables used do not capture the geographical diversity well. For half of the practices, namely soil and water conservation, water harvesting and orchards, the spatial trend is significant.

Adoption maps can be overlaid with suitability maps based on bio-physical suitability map and will show a percentage of farmers that are willing to adopt a given technology on the suitable locations.

**Output**

Adoption maps are described in the up-coming technical report on mapping rainwater management strategies at landscape scale. See 3.1.1.

#### Suitability, feasibility and RMS maps for the Blue Nile

The approach proposed in the concept for mapping rainwater management has been applied to a set of practices, namely terraces (hillside terraces and bench terraces), bunds (soil bunds and stone bunds), orchards (mango trees and apple trees), multipurpose tree, water harvesting, wells, grazing land management, gully rehabilitation. Biophysical suitability criteria have been selected from the database (see 3.2.3) and matched with the available secondary data (see 3.2.4.1). Suitability maps show for each practice where all the biophysical conditions have been met. Each suitability map can be overlaid with the respective adoption map, resulting in a feasibility map, showing the percentage of farmers who are willing to adopt the practice on a suitable location.

Finally, combinations of practices that include at least one practice per landscape zone (upper zone, mid zone and low zone) have been assessed within the FAO watersheds, in so called strategy maps.

**Output** :

Each map and its construction are described in the up-coming technical report on mapping rainwater management strategies at landscape scale. See 3.1.1.

### Other data

In order to validate the suitability and feasibility maps, Nile 3 had a field campaign that aimed at collecting data at two different scales : a farm household survey to capture the farm scale, and farmer focus group discussion to capture the landscape scale.

#### Farm household survey (Gebre)

A farm household survey has been made in collaboration with N2 as well as the N3 partners. Not only farmers in the 3 Nile sites have been interviewed but also in 4 new watersheds in order to validate the maps.

Farmers do not adopt single practices but combine them deliberately.

An important focus of the survey was the adoption and non-adoption of the RMS as well as the interaction of livestock.

Output

Working paper from Gebre

#### Focus group discussions (Catherine)

Focus group discussion have been hold in 4 watersheds outside of the traditional NBDC watersheds, namely Maksegnit (Gondar), Zefie (Debre Tabor), Gorosole (Ambo) and Laku (Shambu). The happy strategy game (see 3.1.3) has been adjusted in order to learn from communities about their preferred and wished rainwater management strategy. This gender disaggregated form of the game, has less fun factor compared to the original game, as there is no exchange and no constraint in term of number of practices and it started of with a participatory mapping exercise. This version of the game can be seen as a quick rural appraisal tool. The discussion allowed to analyze the discrepancy between the current and the wished watershed and through this process understanding what hampers adoption. Whereas many expert always mention that farmers lack in awareness, we met pretty well aware farmers who could point out very specific and rational reasons for non-adoption, such as the lack of access to seeds, the uncertainty of groundwater levels, or the lack of collective vision as a community. We learned that reasons for non-adoption are very context specific; therefore it is essential to identify the right entry point in each community. Solutions suggested by some communities were pretty unexpected, such as chicken farms could improve rainwater management as a new source of income could allow farmer to destock on livestock and reduce the pressure on land.

Communities in general have enjoyed participating in this exercise and made good use of the visiting scientist to ask their questions. Both farmers, scientists and facilitators could learn from each other. ILRI/IWMI could only implement these focus group discussions thanks to a strong commitment of its partners, who organized the logistics on the ground.

Farmers are well aware of the practices that are suitable in their agri-ecology.

Communities have rational reasons for non adoption of rainwater management strategies.

Reasons for non-adoption are very context specific, therefore it is essential to identify the right entry point in each community.

**Output**

*report*

*Matching land and water interventions with community needs: Report of community focus group discussions in four watersheds in Ethiopia,* compiled by C. Pfeifer with the partners

<http://cgspace.cgiar.org/bitstream/handle/10568/25094/nbdc_report.pdf?sequence=1>

*blogs*

<http://nilebdc.org/2012/07/03/multi-scale-participatory-mapping/>

<http://nilebdc.org/2012/08/21/are-fruit-trees-and-chicken-farming-the-future-of-intensification-in-the-ethiopian-highlands/>

<http://catherinepfeifer.blogspot.ch/search/label/N3%20field%20report%20series>

#### Informal institutions in Ethiopia (Catherine)

Institutional economics suggests that informal institutions are good proxy for assessing the collaboration potential of people. As many rainwater management practices , among others terraces and bunds, require that farmers cooperate, and implement the practice together, we followed the crazy idea that by understanding informal institutions about which quite detailed data exist, we might be able to proxy the collaboration potential.

Six dimensions, namely risk coping, access to credit, labor and animal power exchange, natural resource management, conflict resolution and information sharing allows to categorize informal institutions in Ethiopia

Risk reduction institutions are Iddr, Mehaber, women's associations

Market failure institutions are Eqqub, labor and animal power exchange)

Conflict resolution institutions are Gada, elder's group

Generally, in each community there is one institution that most people rely on, but it is a different one in each community. It is therefore difficult to map out social capital based on informal institutions.

There is only very scattered literature about informal institutions in Ethiopia, part of which is in Amharic. We hired an Ethiopian intern from Wageningen University, the Netherlands, to make a comprehensive literature review of the existing formal institutions and understand if one of them could measure the capacity of a community to get organized around rainwater management.

The report found that six dimensions, namely risk coping, access to credit, labor and animal power exchange, natural resource management, conflict resolution and information sharing allows to categorize informal institutions in Ethiopia. Risk reduction institutions are Iddr, Mehaber, women's associations, market failure institutions are Eqqub, labor and animal power exchange, conflict resolution institutions are Gada, elder's group

Generally, in each community there is one institution that most people rely on, but it is a different one in each community. It is therefore difficult to map out social capital based on informal institutions. Therefore we have not pursued the ideas of mapping the cooperation potential.

Output :

<https://docs.google.com/folder/d/0B_BdeBrudKuyU00xV0tBbzVkekk/edit>

### Nile-Goblet (Catherine)

The suitability maps (see 3.2.4.7) that were produced based on the concept of rainwater management (see 3.1.1) are based on the rainwater management database (see 3.2.3). However, experts do not necessarily all agree on the chosen thresholds or do not understand how the maps have been built. Therefore, an open source GIS, the Nile-Goblet tool has been developed, that allows an expert, stakeholder or policy maker to make one own suitability and feasibility maps based on her/his own knowledge and believes about RMS with needing any prior GIS knowledge.

Integrating the user/experts knowledge increases the credibility of the produced maps

Nile-Goblet is an attractive way to share our practice and well as geo-database.

The tool has been promoted in many training for national scientists and learning event with stakeholders and policy-maker. Participants have mentioned that the fact that they can produce their own maps based on their believes allows them to understand better how the maps have been built and know for sure that their believes are well represented.

The Nile-Goblet tool is a very flexible tool that can map any location in the world at different resolutions. However, we prepared the whole geo-database for the Blue Nile at the 1 km resolution, which can be loaded into the tool. Therefore the Nile-Goblet tool with the Nile database is a practical way to share the data we own to the stakeholder with a tool that allows them to use the data without having any prior GIS knowledge.

**Output**

*The software, database and training manuals:*

<http://nilebdc.wikispaces.com/Nile+Goblet+tool+and+training>

*Blog*

<http://nilebdc.org/2013/01/13/best-bet-rainwater-management-strategies-towards-location-specific-best-practice-in-ethiopia/>

<http://catherinepfeifer.blogspot.ch/2013/02/nile-goblet-new-open-source-tool-for.html>

## Analysis of the best land use systems for different parts of the basin in terms of water productivity, livelihoods and economic benefits

### Introduction

### Suitability and feasibility maps compatible with SWAT (Catherine)

The strategy maps at landscape scale based on the suitability and feasibility maps (see 3.2.4.7) are too aggregated to be introduced into a SWAT model and assess the impact of the RMS. Indeed, SWAT works with hydrological response units that are relatively small and can model only a certain level of detail. The best way found to address this issue was to aggregate the different practices into categories for which an impact assessement is SWAT is possible, namely for terraces, strips, orchard, multipurpose tree, irrigation, grazing land management, gullies. For each of these practices, we produce suitability and feasibility maps (that are grids) as part of a strategy. In this way, one suitability and one feasibility maps per practice can be produced, avoiding to produce separate maps for more than 200 possible strategies in the Blue Nile.

Providing suitability and feasibility maps as part of a strategy, reduces significantly the numbers of map needed to represent strategies in SWAT.

**Output**

Technical report on mapping rainwater management at landscape scale see 3.1.1.

### Development domains (An)

In the proposal and initial stages of the project there was a lot of confusion about the exact meaning of and difference between terms such as “suitability maps”/“extrapolation domains”/“recommendation domains” and “development domains”. It was also unclear what exactly would be delivered and how they would be linked. It has become increasingly clear that N3 can and should deliver outputs at two different levels: (i) Methods and maps for targeting and out-scaling specific technologies/strategies, (ii) a (set of) map(s) and guidelines supporting strategic planning at basin and policy level.

In addition to the technology/practice/strategy specific outputs (section 3.3.2), we therefore envisioned a different set of maps and guidelines for targeting policies and larger-scale investments. This set of outputs will include a “rainwater management domain” map. The domains are defined in terms of “market opportunities” and “bio-physical limitations”. The bio-physical limitations or constraints evaluated will include erosion potential, rainfall regimes and soil fertility.

We’ve described and mapped three different rainfall regimes in the basin. They have been extracted from a time series of daily climate data and defined on the basis of the start, length and reliability of the growing season. We’ve combined these 3 rainfall zones with 2 classes of market accessibility and described what kind of development in rainfed agriculture can be expected in each of the resulting 8 domains. We’ll develop specific recommendations for each of the domains, i.e. how investments in infrastructure, extension services, etc can be used to optimise the agricultural production in relation to expected market demands, including livestock synergies with crop production. The final domain maps will provide a spatial framework for setting priorities and targeting investments and interventions. They will be an important discussion support tool for strategic planning at the basin and policy level. We have currently only developed a first version of the map with some initial documentation. We are planning to work on this in the framework of our further NBDC engagement through N5 and aim at presenting it during the up-coming science workshop in June/July.

**Output**

Report on the wiki

# Outcomes and impacts

## Objectives

Beyond just producing documents and maps but defined innovation pathways that will change the attitude from different stakeholders. Many activities, summarized in this section show what has been done in order to promote our work and reach an attitude change through the different innovation pathways.

## Innovation pathways

### Capacity building, trainings and networks

In order to promote the work done in the N3 project, many trainings and capacity building events have been organized. Also a lot of energy has been put into creating the supporting networks and communities of practices in order to create a bigger supporting

#### GIS training for agricultural scientists (Catherine)

In the first year, Nile 3 in very close collaboration with an collaborator from ARARI, built a new basic GIS training that fits the particular needs of the national scientist in agriculture, on the competence based principle (i.e enable participants to learn about GIS on their own, so that they can continue increase their capacities on the job) . Beyond the basic use of ArcGIS, the training also included the use of GPS and the creation of maps based on data collection.

|  |  |
| --- | --- |
|  | There is a huge demand for more geographical literacy (GPS, GIS) not only among our partners but also internally. |

The training was a great success, and the person from ARARI involved, learnt about pedagogical approaches. As he has moved to the Nile Authority as director of knowledge management, he became a much appreciated trainer in his new job as well as at Bahir Dar University, where the developed manual is still in use today.

From this training we discovered that there is a huge demand for more geographical literacy (GPS, GIS) not only among our partners and beyond, but also within our team.

**Output**

Participant and trainer manual

<http://nilebdc.wikispaces.com/GISmanual%20>

*Blog*

<http://nilebdc.org/2011/09/01/nile-bdc-supports-gis-training-for-project-partners/>

<http://catherinepfeifer.blogspot.ch/2011/08/desperate-need-for-more-geographical.html>

#### Nile-Goblet trainings (Catherine)

Three trainings have been organized in order to promote the use of the Nile goblet tool. The first two trainings hold in Gondar and Addis Ababa, targeted young people in the N3 partner organization. Participants have been selected from many different research center, insuring that there is at least one person in each center capable of training other people.

The third training, was an internal training that allowed everyone on the ILRI-Addis campus interested in the Nile-Goblet tool to join the training. About 30 persons joined from many different CGIAR centers.

The trainings have shown expert knowledge about RMS is crucial to understand the usefulness of the tool. Participants with lower education and little background about RMS, have shown more difficulties in using the tool. However, participants with a higher education or sound back ground of RMS could use the tool easily and appreciated the results.

The trainings have shown expert knowledge about RMS is crucial to understand the usefulness of the tool.

**Output**

*Manual*

<http://nilebdc.wikispaces.com/Nile+Goblet+tool+and+training>

*blog*

<http://nilebdc.org/2012/11/23/gis-training-in-addis-ababa-and-gondar-testing-the-beta-version-of-the-nile-goblet-tool>

<http://catherinepfeifer.blogspot.ch/2012/11/open-source-gis-it-it-really-what.html>

#### Learning events (Catherine)

Nile 3 decided to host the first learning event topic working group on technical innovation from the national platform and present the Nile Goblet tool to policy-makers and other stakeholders. A small group of hydrological modelers, high level participants from our partner organisations as well as some other key stakeholder including the Water and Land Resource Center, GIZ and SDC where present and very enthusiastic about the tool.

The fact that we brought together a relatively homogenous group of people that we knew where interested in GIS, allowed us to find people who will promote the tool further even when Nile 3 is finished. The WLRC is looking into options to take up this tool into their center.

Bringing only people who are trulely interested into the national plateform event, allowed to find ways to promote our work beyond the project time.

**Output**

*Blog posts*

<http://nilebdc.org/2012/12/18/thematic-working-group-technological-innovation-hosts-its-first-learning-and-training-event-for-the-benefit-of-the-whole-national-platform-on-land-and-water-management>

#### SAM topic working group (Catherine An?)

The SAM topic working group was created to favor exchange between the different CPWF basins and learn from each other. The meeting hold in Ethiopia started off with a field visit of one of the NBCD sites and the meeting followed in Addis Ababa.

The event allowed to build a community of practice that brought together hydrologists and spatial modelers. Meeting all the participants in person was a great opportunity to know each other better. These relations allowed ILRI and IWMI to, i. collaborate on the new soil map (by?????), to build up a new relationship with Texas University that resulted in exchanges of scientists. Even without any funds, SAM hold a session at the SWAT meeting in India.

**Output**

*Website with all the documents*

[www.sam-twg.wikispaces.com](http://www.sam-twg.wikispaces.com)

*blog*

<http://nilebdc.org/2012/03/09/challenge-programme-for-water-and-food-less-than-two-years-to-go-and-much-science-to-show/>

<http://nilebdc.org/2011/11/29/spatial-analysis-and-modeling-an-interview-with-catherine-pfeiffer/>

### Others

Nile 3 has worked closed together with the Swiss Development Cooperation, in the informal group of Swiss related activities for water management in Ethiopia. Through this participation closed links could be built up with the water and land resource center but also communicate our work to Swiss led NGOs and consultancies. These contacts also led to a new MoU between WLRC and IWMI.

**Output**

*Blog*

<http://catherinepfeifer.blogspot.ch/search/label/development%20cooperation>

## MSCs

Nile 3 has contributed to the most significant stories with two stories that have been retained as basin stories, namely on GIS training (see 4.2.1.1) and one on the GIS mainstreaming within the whole team. For the second round, a story on the on hotspot of degradation (see 3.2.4.5) and happy strategies game (see 3.1.3) has been submitted.

Output

The stories can be found under : <http://nilebdc.wikispaces.com/file/view/MSC%20stories%20of%20NBDC%20results%20oct2011.pdf/294379026/MSC%20stories%20of%20NBDC%20results%20oct2011.pdf>

<http://nilebdc.wikispaces.com/MSC_stories_Round2_Oct2012>

## Gender

Initially, Nile 3 had no gender dimension. However, the gender mainstreaming helped to relook at our work and make sure that we take it into account all our activities. All the household level data we collected was gender aggregated and we put high values on hiring young Ethiopian women as interns. For all our capacity building we have urged our partners to send women to our events. But for many event it was very difficult to recruit women for our trainings.